

United States Department of Agriculture.

DIVISION OF ENTOMOLOGY.

AN IMPORTANT ENEMY TO FRUIT TREES.

THE SAN JOSÉ SCALE; ITS APPEARANCE IN THE EASTERN UNITED STATES
MEASURES TO BE TAKEN TO PREVENT ITS SPREAD AND TO DESTROY IT.

SPREAD OF THE SPECIES IN CALIFORNIA AND DAMAGE DONE BY IT
ON THE PACIFIC COAST.

According to the most trustworthy authority, the San José Scale was first brought to California from Chile on trees received by Mr. James Lick, about 1870. Fruit shippers first noticed it in 1873 at San José, from which fact the popular name of the insect is derived. It spread rapidly until 1880, when Prof. J. H. Comstock, formerly Entomologist to this Department, collected specimens in Santa Clara County, and in the Annual Report of the Department for that year described it scientifically as *Aspidiotus perniciosus*. The specific name was given to it for the reason that Prof. Comstock considered it to be the most pernicious scale-insect known in this country. It swarmed in countless numbers upon the trees in certain orchards, and infested all the deciduous fruits grown in California, except the Apricot and Black Tartarian Cherry. In the course of twelve years the insect spread through all the fruit-growing regions of California, through Oregon, and into the State of Washington. It is known as the worst insect pest of deciduous fruit trees on the Pacific coast, and has caused great pecuniary loss. Many crops of fruit have been ruined, and thousands of trees have been killed.

OCCURRENCES OF THE SCALE EAST OF THE ROCKY MOUNTAINS.

In 1892 the insect was found in the vicinity of Las Cruces, N. Mex., upon Apple, Pear, Plum, Peach, Quince, and Rose. It had been brought into New Mexico upon young trees from California. In the summer of 1893 specimens of pears affected by the insect were received at the Department from Charlottesville, Va., and an investigation showed that a small orchard there was badly infested, the insect having

probably been introduced upon nursery stock purchased in the East about 1890. During the month of March, 1894, the State Board of Agriculture of Virginia, with the help of an agent of this Division, fumigated the infested trees at Charlottesville with hydrocyanic acid gas, and it is probable that the scale has been exterminated at this point. It was deemed necessary to perform this operation before the hatching of the young lice and their spread to the neighboring orchards.

During the same month (March, 1894) specimens were received from the Florida State Agricultural Experiment Station, with the statement that they had been sent in by correspondents at De Funiak Springs, Fla. They are said to occur throughout a 30-acre orchard, and to have been imported from California about 1890. During the same month specimens were brought to this office from Riverside, Charles County, Md., and immediate examination by an assistant in the Division, who was sent to the spot, showed that more than 1,000 peach and apple trees are infested in this locality. Specimens received showed a degree of infestation which we have never before seen. The owner stated that the scales were first noticed three years ago, and expressed himself as of the opinion that the insect was brought into this orchard on nursery stock purchased from a New Jersey dealer.

PROBABILITIES OF ITS OCCURRENCE ELSEWHERE.

If, as we have little doubt, the insect was first introduced into the Charlottesville and Riverside orchards upon nursery stock purchased from eastern dealers between 1887 and 1890, the probabilities are strong that other stock purchased from the same dealers at about the same time was also infested. It is not necessary that the stock purchased from these eastern dealers should itself have come from California, since eastern stock in the nursery may have become infested from California stock in the immediate neighborhood. The scale, therefore, without much doubt, exists in other parts of the East, and measures have been taken by the Department to ascertain all the points at which it occurs. The importance of such knowledge can hardly be exaggerated. The insect spreads rapidly, for a scale-insect, and is the most dangerous scale known.

It is inconspicuous, and will hardly be noticed by the average fruit-grower until it has become very abundant—so much so, in fact, as to practically incrust the bark. Remaining unnoticed in any one locality, it is a constant and immediate menace to the fruit-growing interests for many miles around. The constant portage of nursery stock all through the fruit-growing States of the East, from south to north and from north to south, from east to west and from west to east, affords the most favorable opportunities for the spread of the insect, and there exist at present absolutely no restrictions by which this spread can be limited.

DESCRIPTION OF THE INSECT AND ITS LIFE-HISTORY.

The San José Scale belongs to the same group of scale-insects—the Diaspinæ, or armored scales—to which the common and well-known Oyster-shell Bark-louse of the Apple belongs. It differs from this species, and in fact from all other eastern species found upon deciduous fruit trees, in that the scale is perfectly round, or at most very slightly elongated or irregular. It is flat, pressed close to the bark, resembles the bark of the twigs in color, and when fully grown is about one-eighth of an inch in diameter. At or near the middle of each scale is a small,

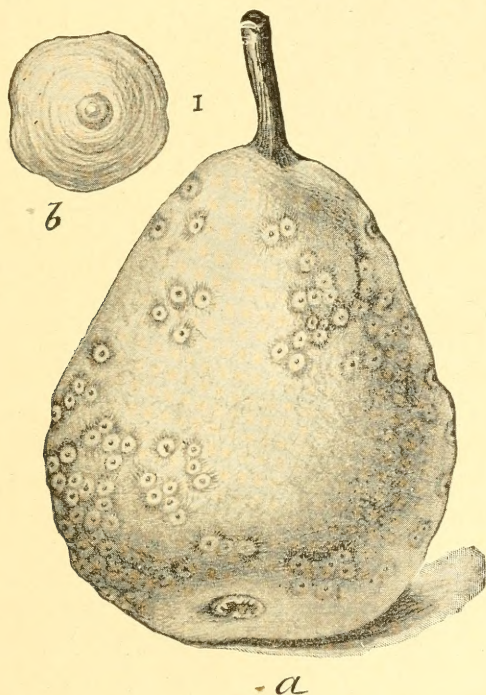


FIG. 1.—San José Scale: *a*, pear, moderately infested—natural size; *b*, female scale—enlarged.
(Original.)

round, slightly elongated black point; or this point may sometimes appear yellowish. The full-grown scale, enlarged, is shown at Fig. 1, *b*.

When occurring upon the bark of the twigs or leaves and in large numbers, the scales lie close to each other, frequently overlapping, and are at such times difficult to distinguish without a magnifying glass. The general appearance which they present is of a grayish, very slightly roughened scurfy deposit. (See Fig. 2.)

The natural rich reddish color of the limbs of the Peach and Apple is quite obscured when these trees are thickly infested, and they have then every appearance of being coated with lime or ashes. When the

scales are crushed by scraping, a yellowish oily liquid will appear, resulting from the crushing of the soft yellow insects beneath the scales and this will at once indicate to one who is not familiar with their appearance the existence of healthy living scales on the trees.

They are easily scraped off with the finger nail, and the bark beneath them will be seen to be darker in color. The natural color of the bark is also somewhat changed, as will be seen by comparing the places from which the scales have been removed with the spots upon which the scales do not occur. The outlines of the removed scales will be noticed upon the bark, and the circumference is frequently changed in color, becoming somewhat purplish. Where the scales do not occur so thickly they are more perceptible, and upon

FIG. 2.—San José Scale: Apple branch with scales in situ—natural size; enlarged scales above, at left. (Original.)

young, reddish twigs the contrast is quite noticeable, as the scales there appear light gray. The younger and smaller scales are darker in color than the older and larger ones, and sometimes appear quite black, while the still younger ones are yellowish.

During winter the insect is to be found in the half-grown or nearly full-grown condition. The young begin to hatch and to crawl from under the female scales shortly after the trees leaf out, and from this time through the summer there is a constant succession of generations. The young louse is an active, crawling creature, very minute, and yellowish in color. The young spread out upon the new growth of the tree, settle down, and each begins to secrete a scale. During its traveling stage it possesses the characters shown at Fig. 3. The male is an active, two-winged insect, and is shown at Fig. 4. The full-grown female loses her legs and antennæ, and bears a very slight resemblance to a living insect. In this stage, the species is shown at Fig. 5.

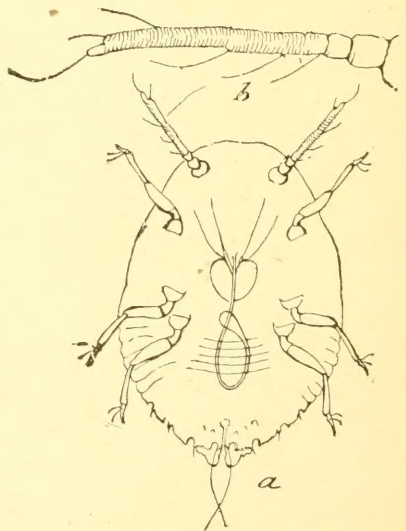


FIG. 3.—San José Scale: a, young larva—greatly enlarged; b, antenna of same—still more enlarged. (Original.)

The insect affects not only the young twigs and limbs and, with young trees, the entire plant, but is also found upon the leaves and upon the

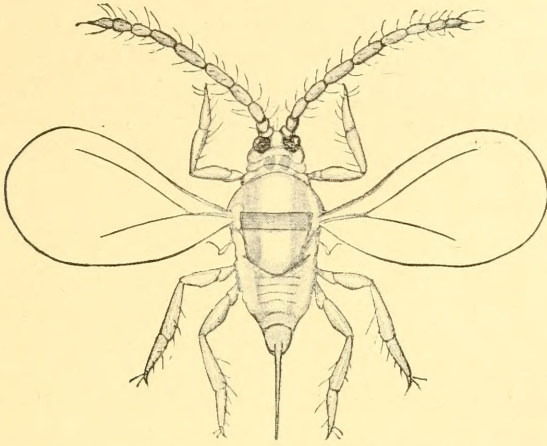


FIG. 4.—San José Scale: male adult—greatly enlarged. (Original.)

fruit. When abundant the fruit is destroyed. One of the most characteristic points in the appearance of the insect upon fruit is the purple discoloration around the edge of each scale. So far as we know this

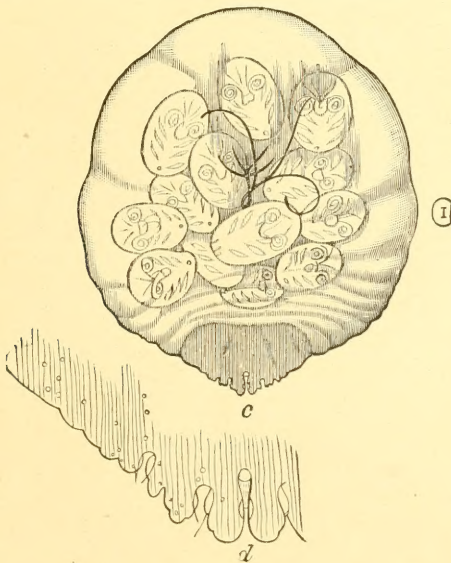


FIG. 5.—San José Scale: c, adult female containing young—greatly enlarged; d, anal fringe of same—still more enlarged. (Original.)

result is confined to this one scale-insect. An infested pear is shown at Fig. 1, a. Upon the leaves the insects have a tendency to collect along the midrib on the upper side of the leaf, in one or more quite regular

rows, and also to some extent along the side ribs. The infested leaves turn brown, but do not have a tendency to fall as a result of the damage.

HOW THE INSECT SPREADS.

Aside from the transportation of the insect upon nursery stock, it may be carried upon fruit sent to market. These are its principal modes of travel from one part of the country to another. In orchards and in neighborhoods its spread is in the newly hatched condition only. The female is wingless and after once becoming fixed can not move; the male alone is winged. The young lice, as before stated, are active, and crawl with considerable rapidity and great persistence, so that they may descend from one tree and crawl for a number of yards to another tree. The spread in this manner, however, is comparatively insignificant. Strong winds may carry the young bodily from one tree to another, but the principal method of spread of these young lice is by means of other insects which are winged, and by birds. The active young lice will soon crawl upon a small winged insect, particularly if the latter is of a dark color, and are carried by it to considerable distances. The young lice also crawl upon the feet of birds which visit the tree and may thus be carried for miles. They are often found crawling upon ants, and ants, as everyone knows, are great travelers.

REMEDIES.

Where trees are found to have become badly infested the safest and, in the long run, the most economical course will be to cut them down and burn them, trunk and branch. Where the infestation is less marked, insecticide washes and sprays may be used. The young lice, before they have begun to secrete scales (and at this time they can only be discovered with the help of a magnifying glass), may be destroyed by spraying with kerosene-soap emulsion. A formula for this mixture follows:

Kerosene.....	gallons..	2	=67 per cent.
Common soap or whale-oil soap.....	pound ..	$\frac{1}{2}$	} =33 per cent.
Water.....	gallon ..	1	

Heat the solution of soap and add it boiling hot to the kerosene; churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens upon cooling, and should adhere without oiliness to the surface of glass. If the water from the soil is hard, or has a large percentage of lime, add a little lye or bicarbonate of soda, or else use rain water. For use against scale-insects dilute one part of the emulsion with nine parts of cold water.

For the older scales, the washes may be divided into those which can be used in summer without damage to the trees, and those which are so strong that they can only be applied during the winter season when the tree is dormant. None of the summer washes are perfectly effica-

cious, and it is doubtful whether any of them will prove of more benefit than the kerosene emulsion just mentioned. Owing to the fact that we have had no summer experience with this insect in the East, we can not state positively the strengths of certain washes which may be used successfully without damage to the trees during summer. In California, however, one of our agents, Mr. D. W. Coquillett, has used with success during the summer a resin wash which was made in the following proportions:

Resin.....	pounds..	20
Caustic soda (70 per cent strength).....	do....	5
Fish oil.....	pints..	3
Water sufficient to make.....	gallons..	100

It is probable that this mixture will not be too strong for eastern trees, since, in general, with other insecticides, the climate of California seems to render trees rather more susceptible to injury than is the case in the East. For a winter wash the same ingredients may be used in the following proportions:

Resin.....	pounds..	30
Caustic soda (70 per cent strength).....	do....	9
Fish oil.....	pints..	4½
Water sufficient to make.....	gallons..	100

The most favored winter remedy in California, however, is the lime, salt, and sulphur mixture. This is generally used throughout the State by progressive fruit growers. It consists of—

Unslaked lime.....	pounds..	10
Sulphur.....	do....	5
Stock salt.....	do....	4
Water to make.....	gallons..	15

This wash will do great damage to the trees if applied during the growing season, *and should be used only in winter*. All the sulphur and half the lime are placed in a kettle, and 8½ gallons water added, after which the contents of the kettle are boiled briskly for about an hour. The solution, which at first is yellow from the sulphur, will turn very dark brown, assuming more or less of a reddish tint, and will finally change from a thick batter to a thoroughly liquid condition, the product being ordinary sulphide of lime. All the sulphur is added to the remaining 5 pounds of lime and the latter slaked, after which the slaked lime and salt are added to the sulphide of lime already obtained, the whole being then diluted with water to make 15 gallons. This should be strained before application, as it does not form a perfect liquid solution, on account of the considerable quantity of undissolved lime, which will soon settle to the bottom unless the solution is constantly stirred while being sprayed.

In the experience of the Division in California and Washington this solution has not been as successful as could be desired, but it has considerable popularity among the fruit growers of California.

Insecticide Apparatus.—For the making of emulsions and the application of insecticides a good force pump is essential. The best apparatus for the making of an emulsion is one of the small hand pumps known as hydronets or aquapults, which are manufactured by all pump makers, the Johnson type being preferable. For the application of sprays to trees either the knapsack pumps for small trees and young orchards and nursery stock, or the larger cart or barrel pumps, will be desirable. The aquapult or hydronet can be obtained for about \$9 and the knapsack pumps for about \$15. The larger barrel and tank pumps, when arranged ready for use, range in price from \$25 to \$75, depending on the size and complexity of the machinery.

A very satisfactory apparatus can be made at much less cost by buying a good force pump at a cost of \$9 to \$12, and fixing it to a strong barrel or wooden tank. All the pump manufacturers have pumps that are adapted to this purpose, and the cost of the apparatus by this means will be limited practically to the cost of the pumps, nozzles, and hose, which should not exceed at the outside \$15.

The nozzle in most general use is of the Cyclone type, and is ordinarily styled on the market the Vermorel nozzle. This will prove very satisfactory, particularly for smaller trees, and is the one commonly supplied with the knapsack sprayers. The Nixon nozzle, which is supplied only with the Nixon pumps, is a very serviceable one, and particularly advantageous for use with large trees.

The Gas Treatment.—This method has not been extensively used in California against this insect, but has been used with very considerable success against the so-called Red Scale upon orange and lemon trees. It is an expensive operation, but is unquestionably more thorough than spraying. Trees infested with different kinds of *Aspidiotus* have been entirely freed by a single application of this gas.

The treatment consists in enveloping the tree in an air-tight tent and afterwards filling the tent with hydrocyanic acid gas, generated from fused potassium cyanide, sulphuric acid, and water. This gas is much lighter than air and as soon as generated rapidly rises and fills the tent. It is of course fatal to all forms of animal life, and care must be exercised in using this treatment. The tent is usually constructed in the form of an octagonal sheet, of what is ordinarily known as 8-ounce duck, and is afterwards oiled with boiled linseed oil. A tent of this kind measuring 40 feet in diameter will cost about \$50, and other sizes in like proportion. Almost any glazed earthenware vessel will answer the purpose of a generator. The potassium cyanide used is usually of 60 per cent strength and the sulphuric acid is of the ordinary commercial brand. The proportions are, 1 ounce by weight of the cyanide, 1 fluid ounce of the acid, and 3 fluid ounces of water. This is sufficient for 150 cubic feet of space inclosed by the tent.

The water is first placed in the generator, the acid added, and after the generator is placed under the tent the cyanide is added to the solu-

tion. The cost of the chemicals mentioned is small. The tree is subjected to the action of the gas for about half an hour. In treating trees 10 feet high or less, the tent can be placed over the tree by hand, but for those of greater height than this some sort of apparatus must be used for the purpose of elevating the tent over the tree. An apparatus in the form of a tripod, with a pulley at the top, serves this purpose very well.

The following table of the relative amount of ingredients to height and girth of tree top will be found useful:

Height of tree.	Diameter of tree top.	Water.	Sulphuric acid.	Potassium cyanide.
<i>Feet.</i>	<i>Feet.</i>	<i>Fluid ozs.</i>	<i>Fluid ozs.</i>	<i>Ounces.</i>
6	4	$\frac{3}{4}$	$\frac{1}{3}$	$\frac{1}{3}$
8	6	2	1	1
10	8	$4\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{4}$
12	10	8	4	4
12	14	16	8	8
14	10	10	5	5
14	14	19	$9\frac{1}{2}$	$9\frac{1}{2}$
16	12	16	8	8
16	16	29	$14\frac{1}{2}$	$14\frac{1}{2}$
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33

The best results will be obtained by treating the trees during the colder portion of the year or at night, as the gas is more liable to injure the trees when used in very warm weather than it is when the weather is cooler.

The very poisonous character of the potassium cyanide itself and of the hydrocyanic-acid gas must be strongly impressed upon those who undertake to use this treatment for the first time. The cyanide must be kept where children and animals can not get at it; it must be kept in tightly closed vessels, and must be plainly labeled "Poison." During the process of treatment every care must be taken to prevent human beings or domestic animals from inhaling the gas.

HOW TO PREVENT THE SPREAD OF THE INSECT.

As we have shown in a previous paragraph, the principal mode of spread is by commerce in nursery stock, cuttings, and fruit. The time will come in the immediate future when some kind of quarantine regulations will have to be established by States, or by large fruit-growing districts. Should this species already have obtained the firm foothold in the East which we suspect, New York, Michigan, and other States in which the pomological interests are great should immediately, by act of legislature, establish quarantine regulations similar to those in force at the present time in the State of California. In the meantime no orchardist should admit a single young fruit tree, or a single cutting, or a single bud, from a distance into his orchard without first carefully examining it and satisfying himself absolutely that it does

not carry a single specimen of the San José scale. If this plan is adopted by everyone interested, and without exception, the rate of spread of the species can be limited to the natural spread by crawling, by winds, and by the aid of other insects and birds.

We wish particularly to impress upon the minds of fruit growers that as soon as this insect is found to occur in an orchard the most strenuous measures must be taken to stamp it out. No halfway measures will suffice. The individual must remember that not only are his own interests vitally at stake, but those of the entire community in which he resides. Trees badly infested should be instantly burned, as previously stated. The individual may think that he can not bear the loss, but the loss in consequence of the slightest neglect will be much greater. The fact, too, that there is a community of interests among fruit growers in this matter must not be lost sight of. Fruit growers must be mutually helpful in an emergency like this.

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Acting Entomologist.

Approved:

J. STERLING MORTON,
Secretary.

WASHINGTON, D. C., *April 4, 1893.*

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